**Comparing pH**

Solution X Solution Y

A close up of a lamp

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pH2 pH1

How does the acidity of the two solutions compare?

Put a tick (✓) in the box next to the best answer.

|  |  |  |
| --- | --- | --- |
| **A** | Solution Y is half as acidic as solution X. |  |
|  |  |  |
| **B** | Solution Y is twice as acidic as solution X. |  |
|  |  |  |
| **C** | Solution Y is 10 times as acidic as solution X. |  |
|  |  |  |
| **D** | Solution Y is a tenth as acidic as solution X. |  |
|  |  |  |

*Chemistry > Big idea CSU: Substances and properties > Topic CSU3: Acids and alkalis > Key concept CSU3.1: pH scale*

|  |
| --- |
| **Diagnostic question** |
| **Comparing pH** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Acidic and alkaline solutions may be compared using the pH scale. |
| Observable learning outcome: | Compare acidity or alkalinity using the pH scale. |
| Question type: | simple multiple choice |
| Key words: | solution, acidity |

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This diagnostic question probes understanding of ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**What does the research say?**

Sheppard (2006) lists three things that high school students do not generally understand about pH.

1. pH is a measure of concentration
2. pH is not a measure of strength
3. pH is a logarithmic and not a linear scale

Concentration of hydrogen ions, strong and weak acids and logarithmic scales are not generally introduced to younger (age 11 to 14) students.

However, it is not unlikely that simplified teaching to these students could reinforce these misunderstandings at a later stage.

In this key concept, the phrase ‘more acidic’ is deliberately used rather than ‘stronger acid’. This is more consistent with the idea of concentration and avoids mention of strength which may cause confusion when learning about strong and weak acids later (where a strong acid is an acid which disassociates completely in water).

It is likely, if not explicitly told otherwise, that students will assume that the pH scale is linear. There may be benefits in making clearer at an earlier stage that this is not correct. The pH scale could be explained without logarithms in terms of a multiplication factor of ten between pH numbers. For example, pH1 is ten times more acidic than pH2. pH 14 is ten times more alkaline than pH 13.

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**Ways to use this question**

Students should complete the question individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

It may help some students to present the answer options more diagrammatically.

**Expected answers**

C

**How to respond - what next?**

A student who selects A or D may misunderstand how pH numbers relate to acidity. The lower the number, the more acidic the solution.

Selection of option B suggests that the student thinks that the pH scale is linear rather than logarithmic (acidity changes by a factor of ten from pH 2 to pH 1.)

If students have misunderstandings about the pH scale it may help to introduce students to other non-linear scales such as the Richter scale which is used to measure the magnitude of earthquakes. The following BEST ‘response activities’ could be used in follow-up to this diagnostic question:

* Unusual scales

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden and Alistair Moore (UYSEG)

**References**

Sheppard, K. (2006). High school students' understanding of titrations and related acid-base phenomena. *Chemistry Education Research and Practice,* 7(1)**,** 32-45.